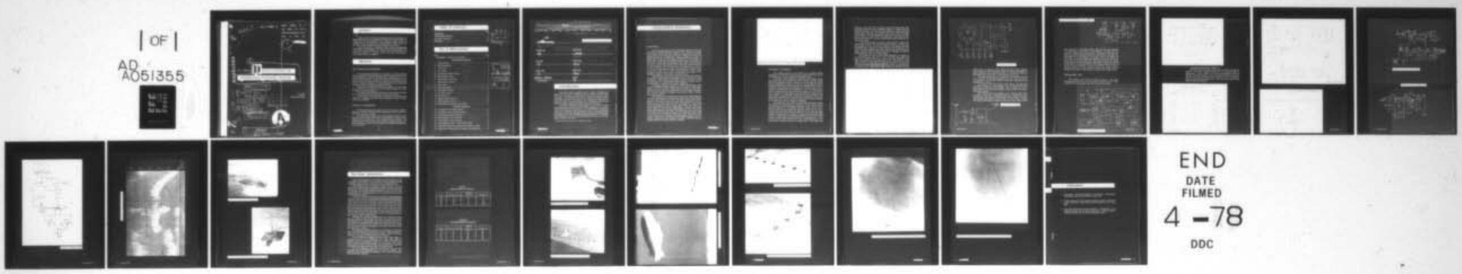
AD-A051 355 NAVY ELECTRONICS LAB SAN DIEGO CALIF F/G 17/7
DEVELOPMENT OF EXPENDABLE SOUNDING DEVICES. (U)
APR 47 W K LYON, E F KIERNAN

UNCLASSIFIED NEL-7 NL

| OF |

AD
A051355



END
DATE
FILMED
4 -78
DDC

MOST ProJect -4

Return To ~~847~~

USNEL REPORT NO. 7
DPS INDEX NO. 201-6.4
BUSHIPS PROBLEM NO. D14.1C
DATE: 25 APRIL 1947

[redacted]

1

AD A051355

Final Report

DEVELOPMENT OF EXPENDABLE SOUNDING DEVICES

9 Final rept.,

10 W.K./Lyon E.F./Kiernan

11 25 Apr 47

12 23P.

14 NEL-7

AD NO.
DDC FILE COPY

W. K. LYON
E. F. KIERNAN
RESEARCH DEPARTMENT

74

253 550 JOB

preface

Numerous devices have been developed for the reconnaissance of a beach approach prior to an amphibious landing. This report describes two methods for the determination of the underwater beach profile. One method employs a remote-controlled, self-propelled, recording fathometer; the other, a simple line-float device for dropping from aircraft.

The work consisted of exploratory tests only and was performed intermittently during 1945 and 1947. The following individuals contributed to the solution of the problem: L. P. Delsasso (now at University of California, Los Angeles); L. E. Smith (now at San Diego State College); R. B. Doherty; and C. H. Milligan.

abstract

SELF-PROPELLED FATHOMETER

The self-propelled fathometer is essentially a remotely controlled torpedo equipped with sounding apparatus which measures the depth of the water immediately beneath it and transmits the measurements to a control point where they are recorded. The control and telemetering circuits are provided by radio links between the torpedo and the control point. The device is intended, primarily, to provide soundings along the approaches to beaches previous to amphibious landing operations.

The control point might be located in an airplane, a surface vessel, or a submarine on the surface. The control operator guides the torpedo by means of visual observations.

An experimental model was built, and tests were made in San Diego Bay. A recording of the bottom obtained in these tests is shown.

A final design of the fathometer would involve the requirements incidental to launching the device from an airplane in flight, a surface vessel, or a submarine.

LINE-FLOAT FATHOMETER

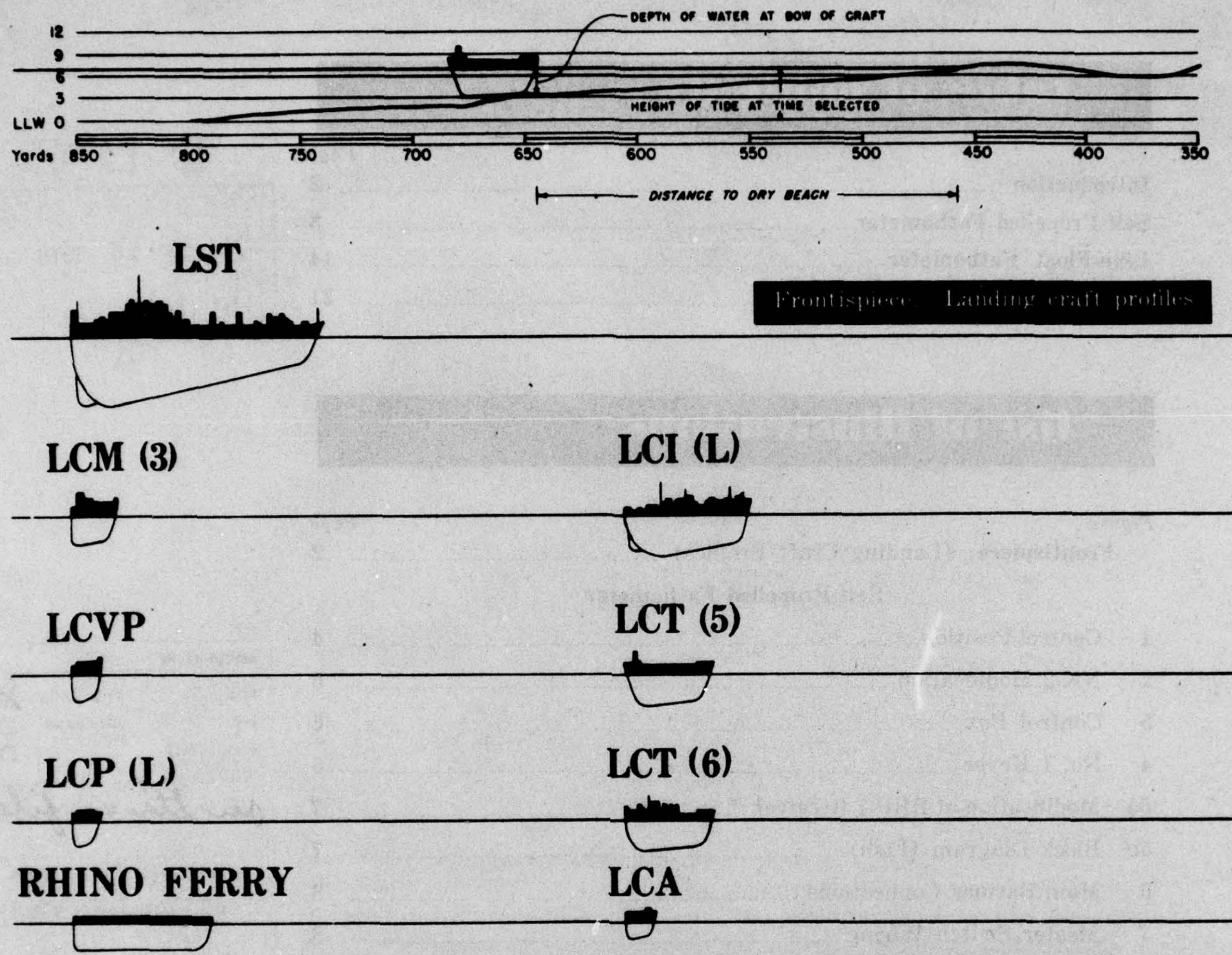
The line-float fathometer appears to be the simplest and cheapest method. It will likely fulfill the tactical requirements for many operations. Exploratory tests are described.

The fathometer consists of ten wooden plaques uniformly spaced along a 20-foot line which is fastened to a steel anchor plate. Many of these assemblies are scattered over a beach approach from an aircraft. The anchor plate falls to the bottom and the number of plaques floating on the surface indicates the depth. This information is recorded photographically from the aircraft.

[redacted]D

table of contents

list of illustrations



Frontispiece. Landing craft profiles

introduction

Amphibious landing operations require accurate information regarding the underwater topography along the approach beaches. Since wind, wave, tide action, and other factors, continually operate to change conditions, it is essential that the data be obtained immediately prior to the landing operation. The methods used in acquiring the data must be practical in spite of enemy proximity. The relationship between beach profile and landing craft profile is illustrated in the frontispiece.

A variety of methods has been suggested and a number involving aerial photography have been covered rather thoroughly in the report, "Underwater Depth Determination,"[1]* by the Photographic Interpretation Center. The development work carried on at the U. S. Navy Electronics Laboratory included the following: CXKD Lead-Line Expendable Sounding Equipment,[2] the UDT Paddleboard Sounding Equipment,[3] the Self-Propelled Fathometer, and the Line-Float Fathometer. The last two are discussed in detail in this report.

* Superscript numbers refer to list of references on page 21.

self-propelled fathometer

DESCRIPTION

The experimental model of the self-propelled fathometer was built in the hull of a self-propelled sonar target, or "fish," which was discarded from a previous project. The "fish" consisted of a cylindrical center section approximately 2 feet in diameter and 4 feet 10 inches long. Conical end sections extended the over-all length, including propeller and rudder, to twelve feet. In order to obtain sufficient buoyancy, it was necessary to attach tanks on both sides of the center section. Access to the interior of the various compartments was afforded by cover plates and hand holes. The forward conical section housed a ¾ h.p., 32-volt d.c. motor which drove a 12-inch propeller in the nose. The motor was supplied from a bank of six 12-volt, 68 ampere-hour batteries (series-parallel connected) housed in the center section. The aft conical section contained a vacuum pump, pneumatic steering controls, and a gyrocompass. The balance of the electronic equipment was mounted in the center section.

The apparatus located at the control point included the following: the modified recorder-driver-receiver-amplifier unit of an NK-2 portable fathometer; a radio transmitter (BC-463A, originally designed to be used in conjunction with radio-controlled target planes); a special receiver (modified RBF-1); together with accessory equipment.

The apparatus located in the "fish" included the following: a radio receiver (BC-464B, originally designed for use in radio-controlled target planes), a keyer-driver unit, a special radio transmitter, a gyrocompass, pneumatic steering mechanism and propulsion motor, together with associated auxiliary equipment including vacuum pump, relays, batteries, switches, and antennas.

The operation of the mechanism is as follows: the control point has provision for transmitting five accurately set audio tones. These are picked up by the radio receiver in the "fish" and operate relays (either electromagnetic or electronic) which close and/or open appropriate circuits to provide various control functions. The five functions are: speed control (low, intermediate, and high), reverse, right rudder, left rudder, and driver trigger. The first four are self-explanatory; the fifth is the keying signal, originating in the recorder, which triggers the driver unit to excite the projector mounted on the "fish." The hydrophone on the "fish" picks up the echo from the bottom and feeds it to the radio transmitter, which in turn sends it to the receiver at the control point. The output of this receiver is connected to the NK-2 receiver-amplifier-recorder, where the depth is registered. The gyro compass is arranged to maintain any given heading whenever the rudder control is in neutral.

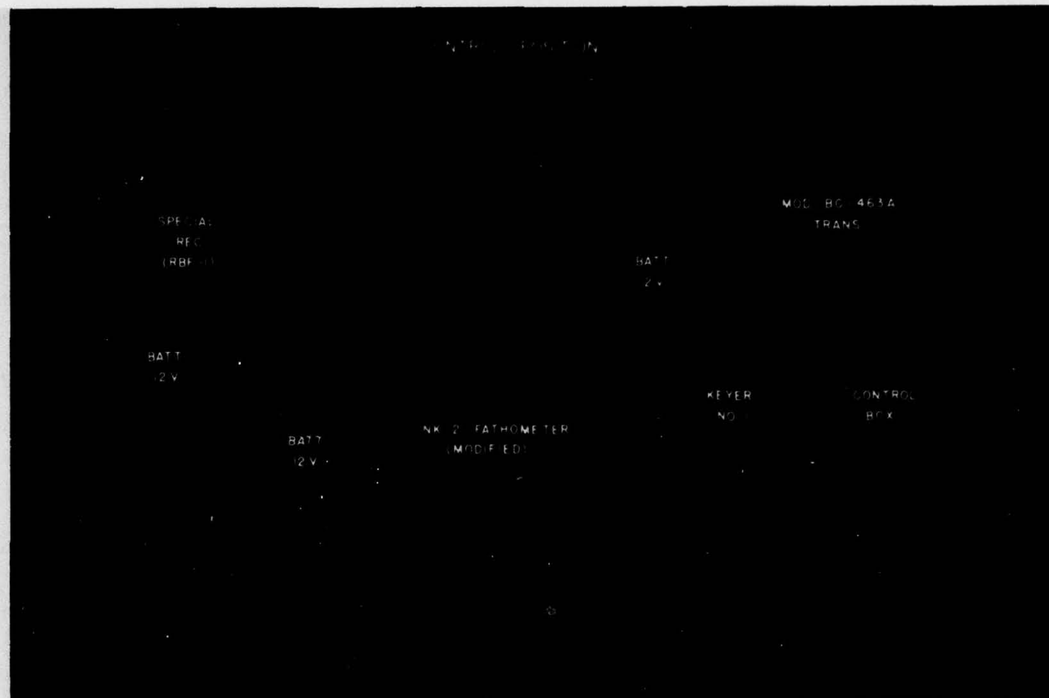


Figure 1. Control position of the self-propelled fathometer.

DISCUSSION OF PROBLEM

The problem involved (a) the division of a standard portable fathometer type NK-2 into two sections with suitable radio links, and (b) the provision of a remote controlled self-propelled vessel.

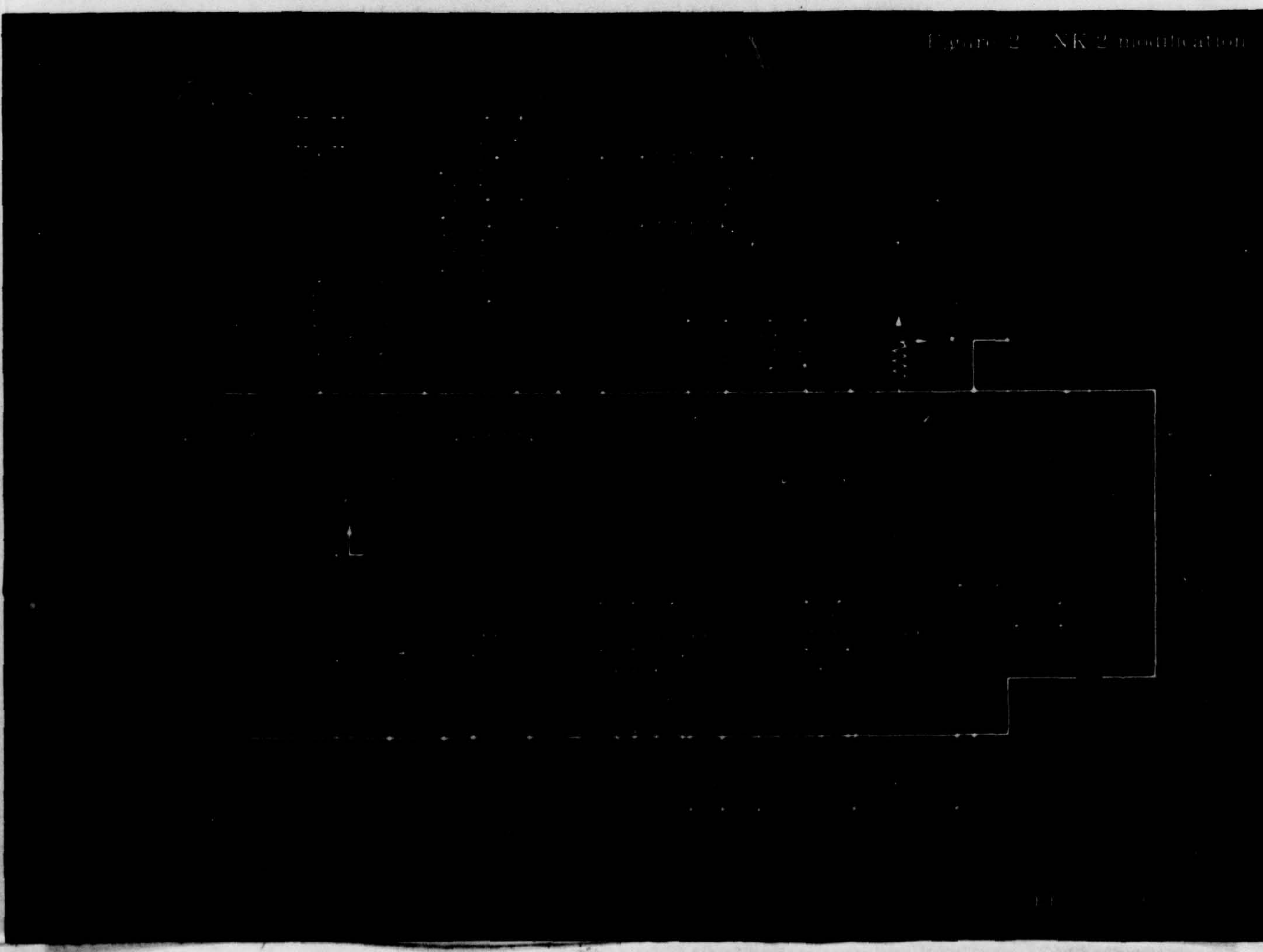
One section of the fathometer, consisting of the projector, hydrophone, and driver, was mounted in the "fish," while the recorder, keying, and receiver-amplifier units were located at the control point. The control position arrangement is blocked out in figure 1. The modifications made in the NK-2 fathometer are shown in figure 2. To complete the driver circuit the leads to the projector were short-circuited. A 5-ohm resistor was inserted in the cathode lead of the strobotron, V-301; the drop produced across this resistor when the tube fired on the keying cycle was fed to No. 1 keyer, consisting of an 884 thyratron connected between the cathode of the audio oscillator in the BC-463A transmitter and ground. When the 884 fired, the audio oscillator sent out the tone which operated the No. 2 keyer-driver in the "fish." It was necessary to place a 22.5-volt bucking battery in the cathode of the 884 to overcome the tube drop.

No modifications were made in the BC-463A transmitter proper. The control cable was connected to a control box, shown in figure 3, which was designed to provide the desired functions. A rotary switch with six positions, including low, intermediate, and high speeds, two off, and reverse, operated the motor driving the propeller. A brief tone was transmitted as the switch moved from one position to the next. The tone signal operated a stepping relay in the "fish" to provide the corresponding speed function. A push button was connected in parallel with the rotary switch so that the latter could be synchronized with the stepping relay. It was necessary for the rotary switch to be in the reverse position before the motor could be reversed by means of a toggle switch. This feature was

necessary, as the motor drew excessive current if reversed under load. The toggle switch sent out a momentary signal as it passed from one position to the other. The rudder control consisted of a second nonlocking toggle switch which sent out appropriate tones when held in the right or left positions. The gyrocompass was caged, and the rudder held hard over as long as the toggle switch was positioned to either right or left. The output of keyer No. 1 was fed into the control cable through the control box (see fig. 4).

It was found necessary to provide a special receiver to pick up the signals from the "fish" and feed them into the recorder. A RBF-1 unit was modified (fig. 5a) to accept the 8024 kc. pulse signals, amplitude modulated, which originated as echoes picked up the hydrophone in the "fish." The wide acceptance band (600 to 15,000 cycles) gave satisfactory fidelity, while the double conversion feature and a shielded loop antenna provided isolation from the BC-463A signals.

The signals sent out by the BC-463A transmitter were picked up by a RC-57A receiver in the "fish." Four of the audio tones operate the relays in the receiver which in turn control the various functions of the "fish" through the main relay panel (see fig. 5b). The fifth tone, which triggers the No. 2 keyer-pulser, is tapped off the plate of the 1S4 tube and excites the grid of the 6C5 tube in the No. 2 keyer. It was necessary to incorporate this phase-inverter stage between the 1S4 and the 2050



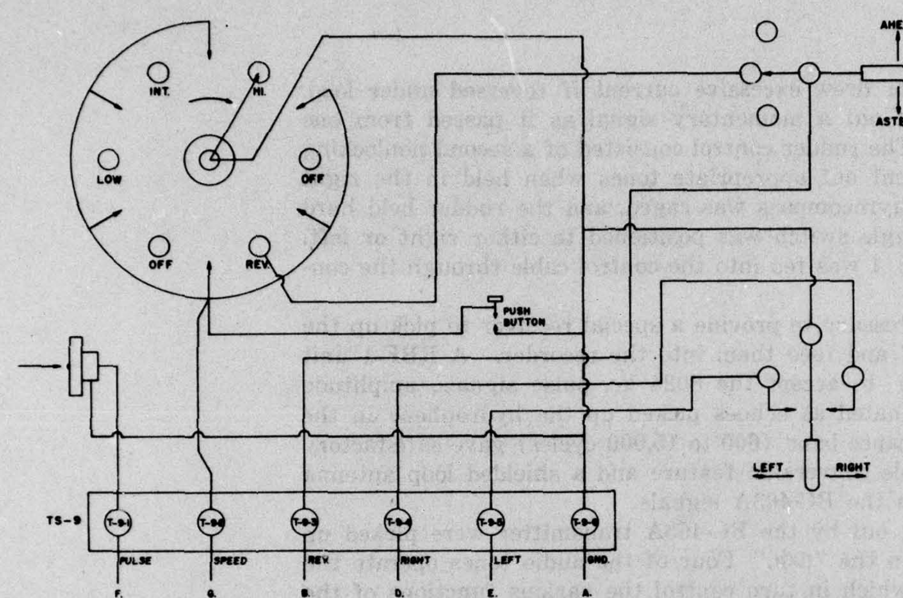


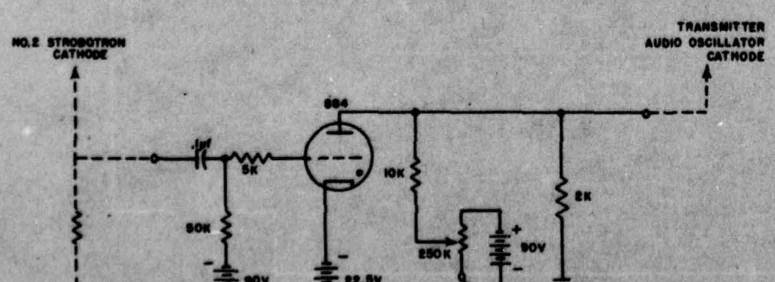
Figure 3. Control box

thyratron grid to eliminate several milliseconds delay when a negative signal triggers the 2050. Electronic relays were essential throughout in order to eliminate time delay between closure of the keying contacts in the recorder and the excitation of the projector (see fig. 11).

The echoes picked up by the hydrophone on the "fish" were fed into a specially built amplifier-transmitter (fig. 10). This unit had an r-f output of 3 to 4 watts and a fidelity characteristic comparable to the modified RBF-1 receiver.

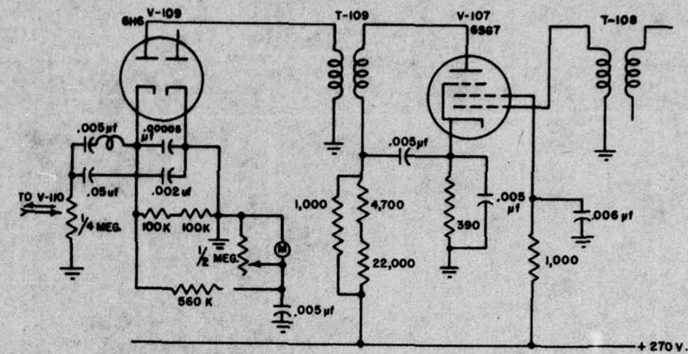
The layouts of the main battery, master switch, and relay panel are shown in figures 6, 7, and 8, respectively. The master switch had three positions, ON, OFF, and CHARGE. Battery charging was accomplished by means of an external connection on top the "fish" and a heavy-duty tungar rectifier.

The steering mechanism consisted of two actuating pnueumatics or bellows, a slide valve, a differential bellows, a gyrocompass, and a vacuum pump, together with the associated tubing, bleeder, and filter. The vacuum pump supplied a partial vacuum to the actuator bellows, causing one or the other to collapse and move the rudder when the slide



[illegible]

Figure 5a. Modification of RBF-1 receiver



valve was moved to the proper position. The slide valve was controlled by a differential bellows which was positioned to a neutral point by means of a bleeder and a spring system. The amount of pressure supplied to the differential bellows was in turn controlled by a port and vane arrangement in the gyrocompass. If the "fish" varied in its heading, the gyro either increased or decreased the pressure so that the bellows system moved the rudder to bring the "fish" back on course. To change course, signals from the control point actuated one or the other of a pair of solenoids on the gyro (see fig. 9). The solenoids shifted the vane in the gyro to move the rudder, through the valve and bellows system as shown in figure 12. The gyro was caged automatically during a turning movement, and took over immediately on release of the rudder control.

EXPLORATORY TEST

The complete unit is shown in figures 14 and 15. The control equipment was set up at the Net Depot in San Diego Bay, and the "fish" was launched in the adjacent basin and trial runs were made.

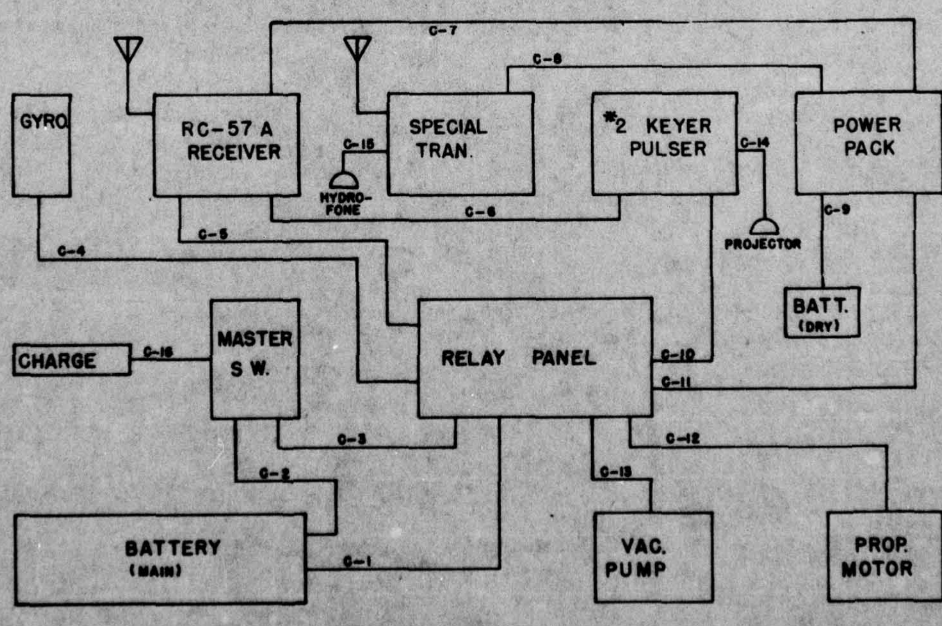


Figure 16. Block diagram [illegible]

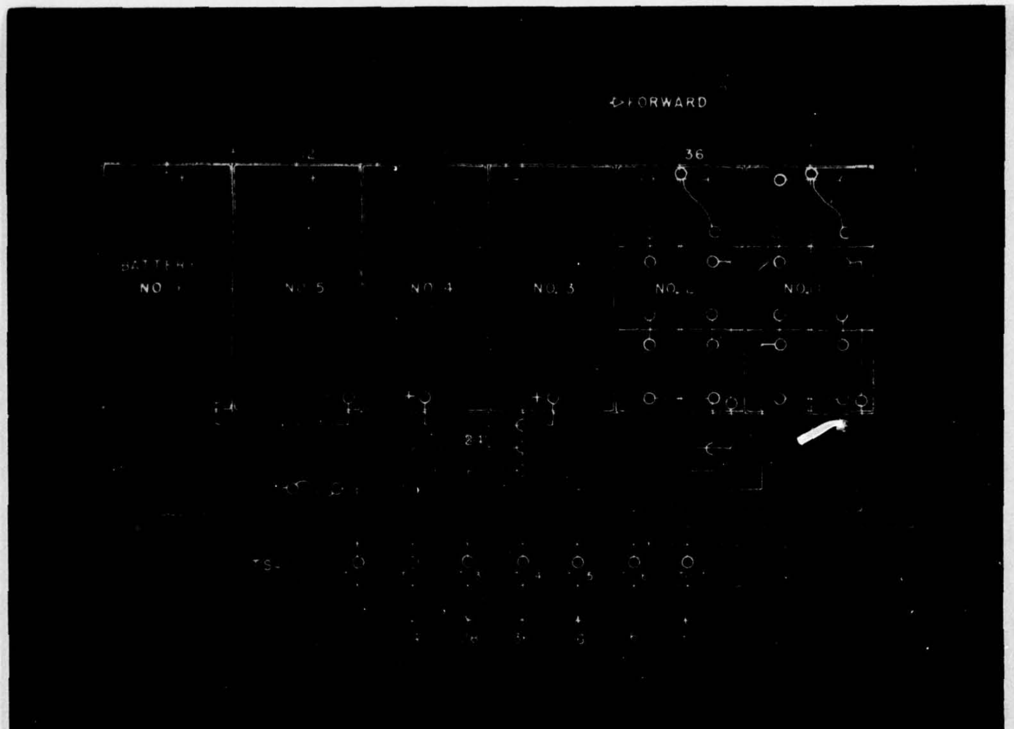


Figure 6. Main battery connections.

A sample record is shown in figure 13.

The run starts at the right of the chart just above the dark line marked 0. The record proceeds toward the left to a maximum depth of approximately 18 feet, shallows to 9 feet as the fathometer crossed a sand bar, and increases again to 18 feet, and finally decreases to less than one foot at the left end of the record. The fainter trace of a double reflection is seen above the primary trace. This record was taken in calm water over hard sand bottom.

Figure 7. Master switch wiring.

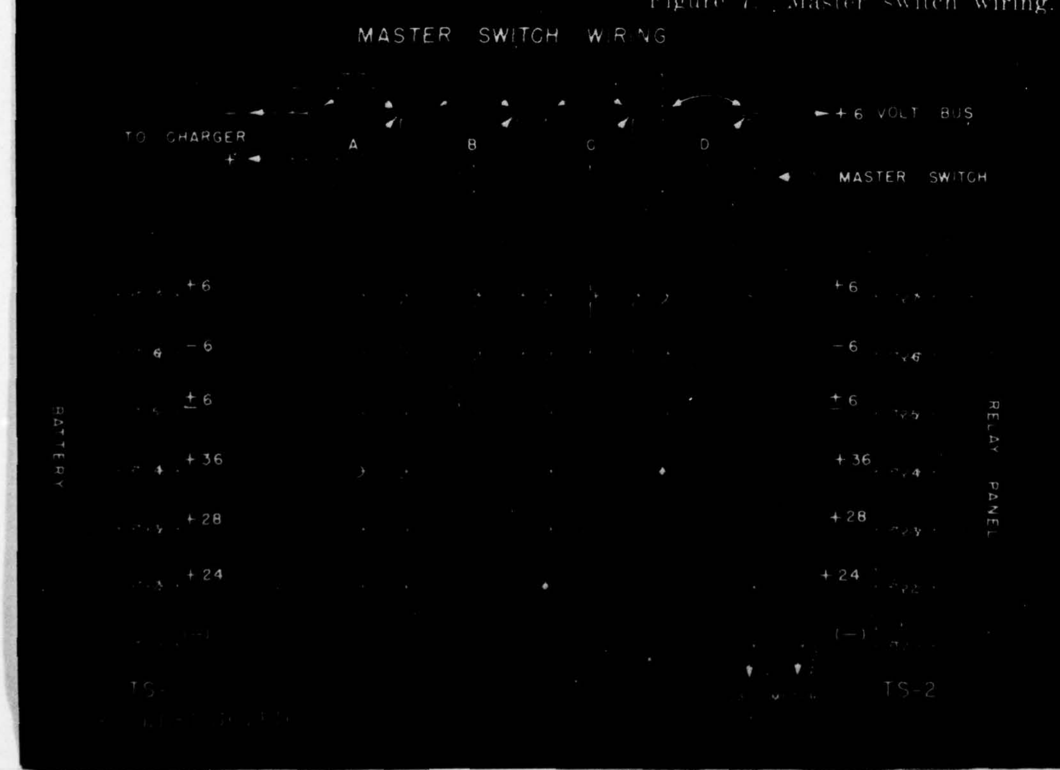
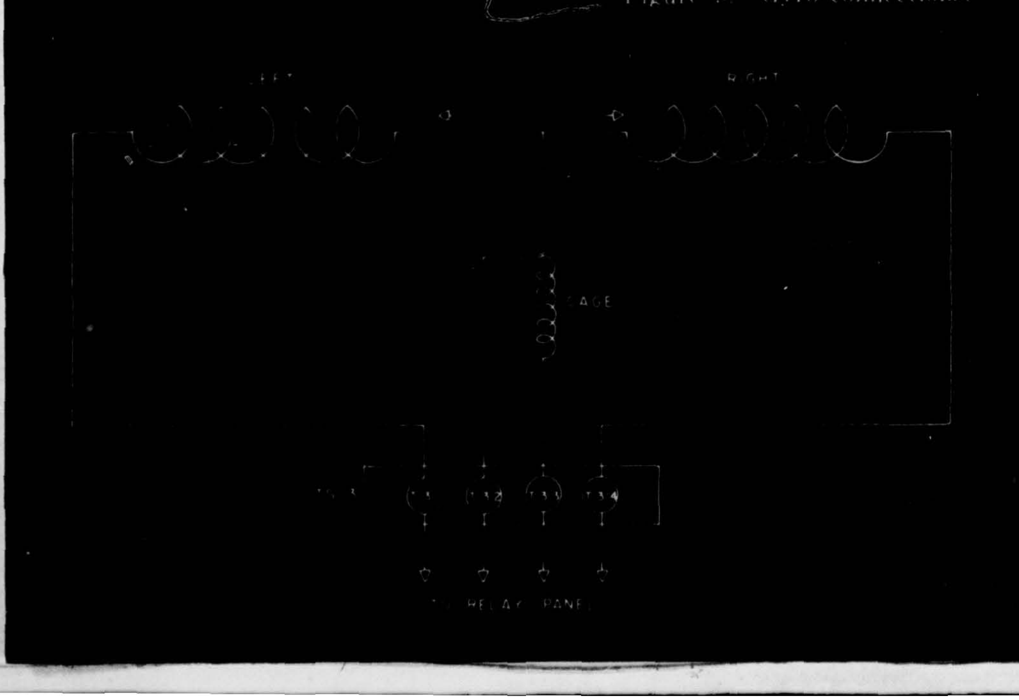


Figure 8. Relay panel.

Figure 9. Gyro connections.



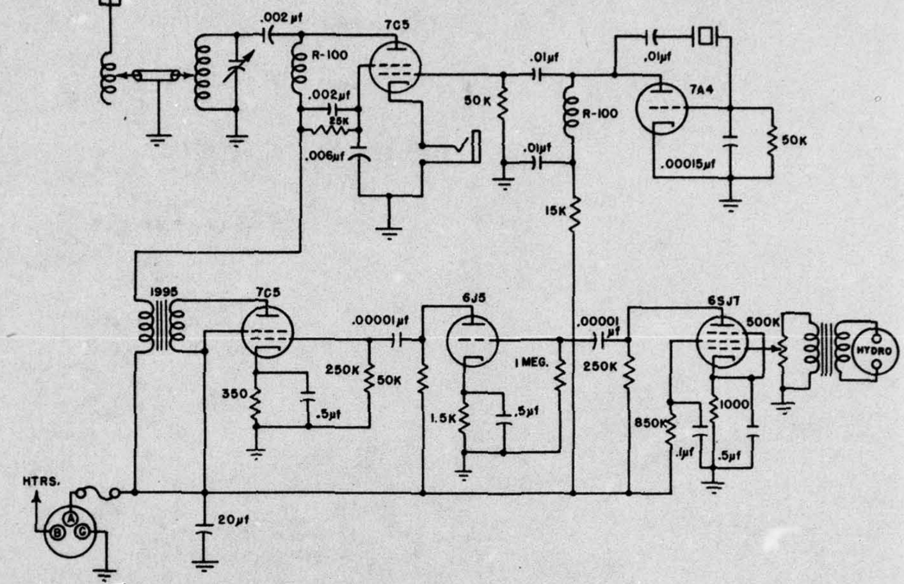
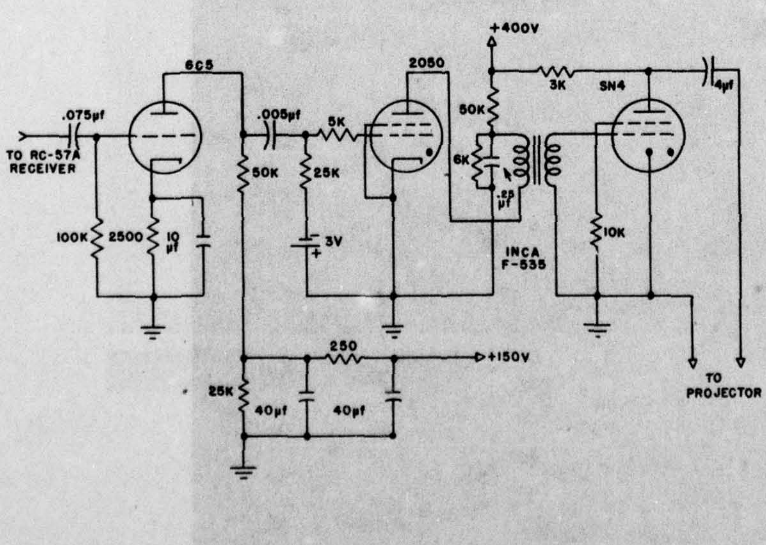


Figure 10. Transmitter-amplifier.

Figure 11. No. 2 keyer-pulser.



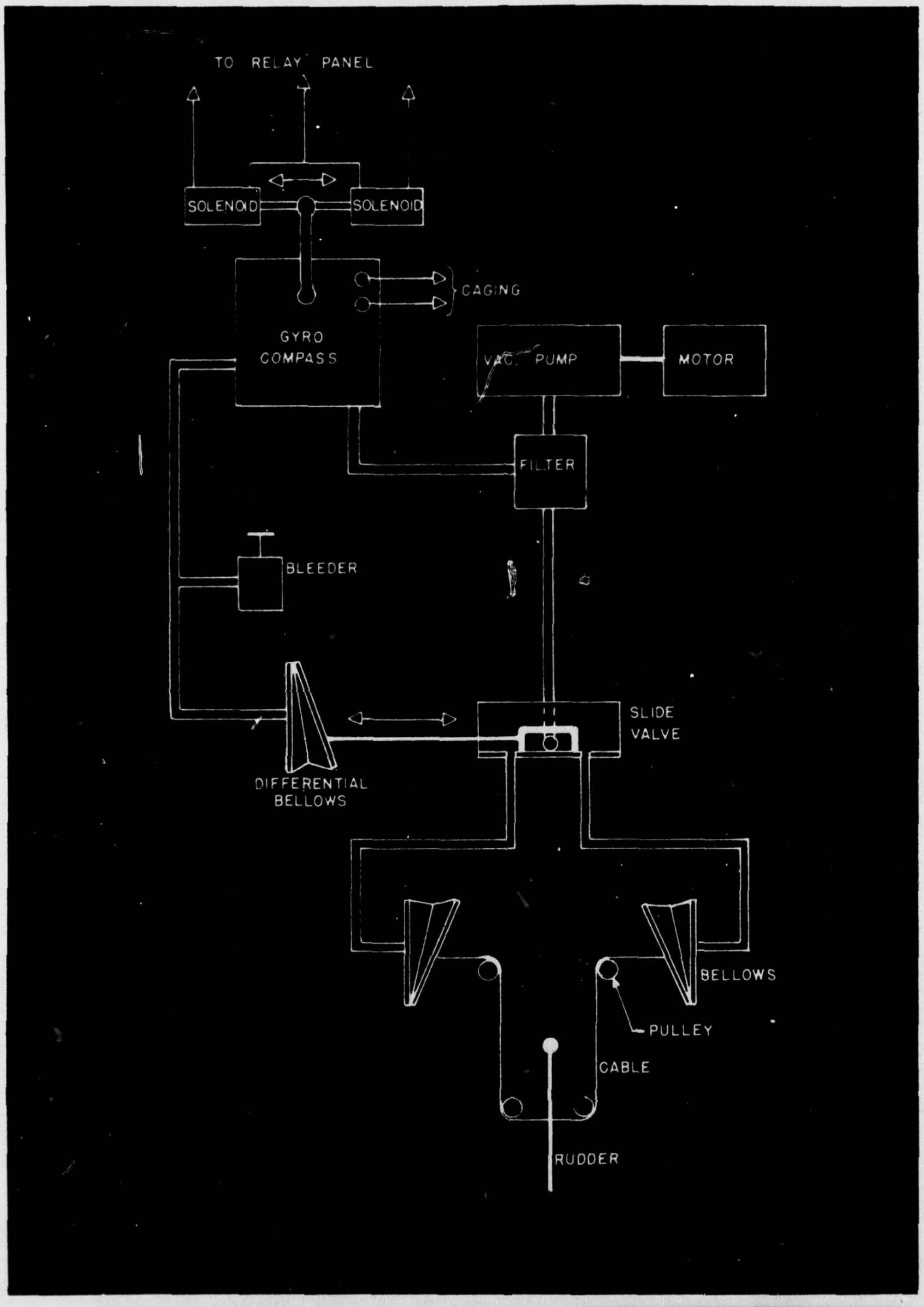


Figure 12. Rudder control.

Figure 13. Sample depth recording.

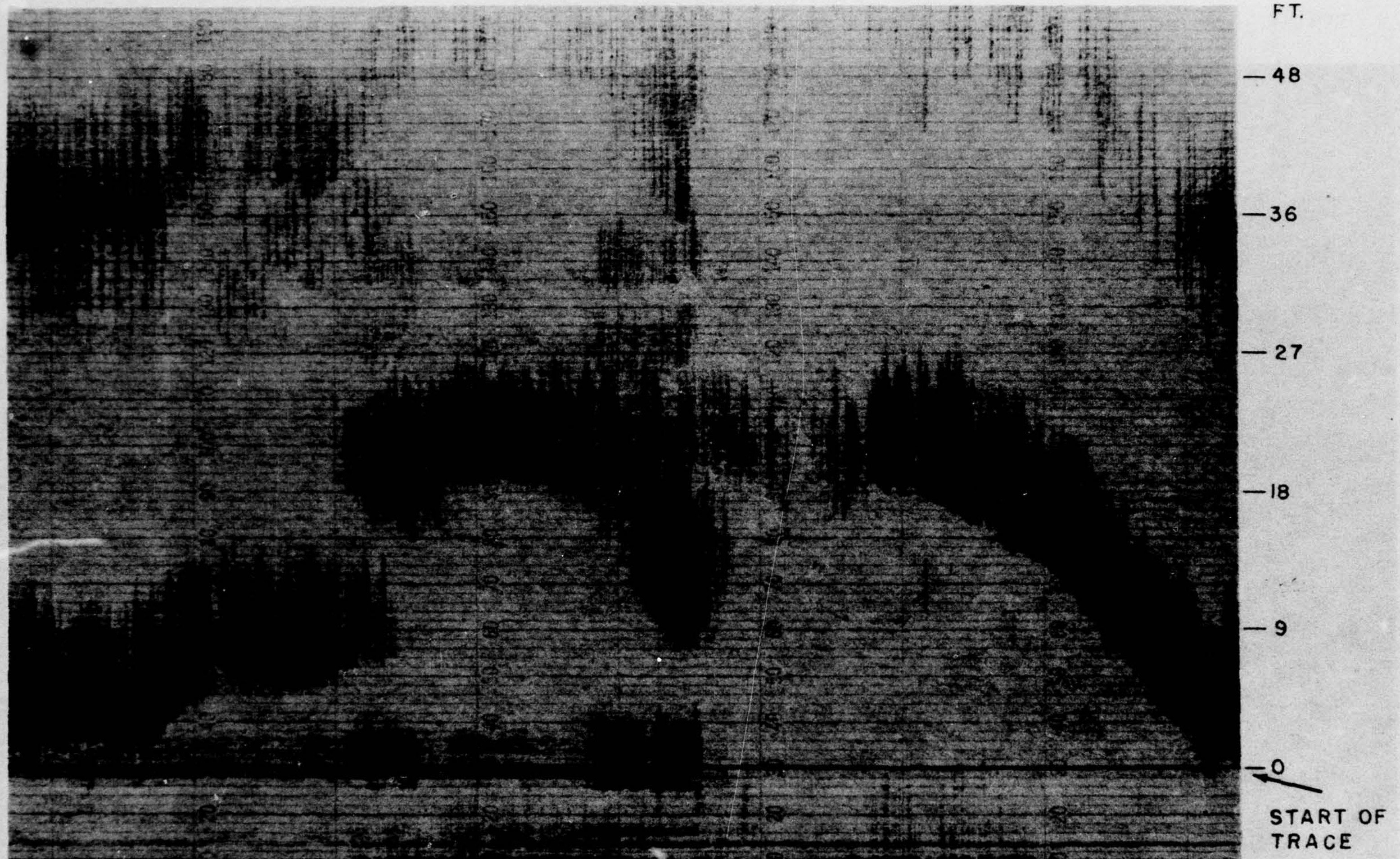


Figure 14. Self-propelled fathometer.

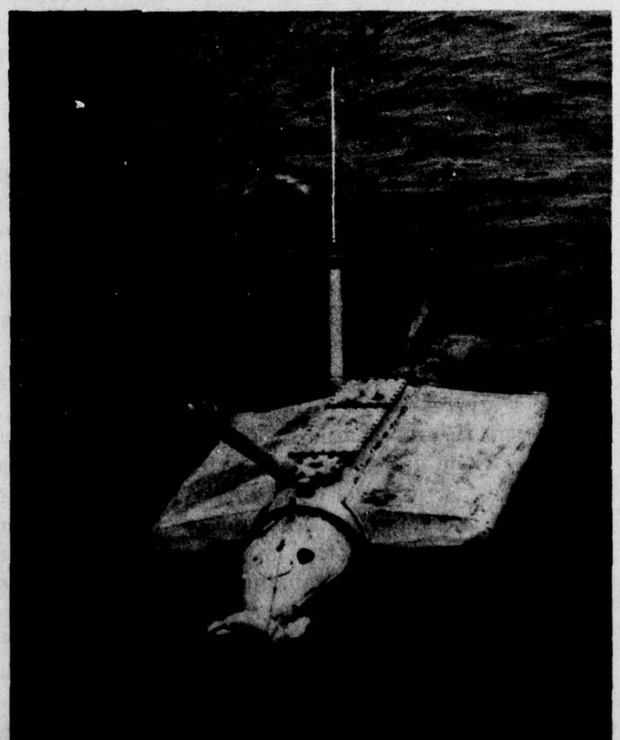


Figure 15. Self-propelled fathometer in the water.

line-float fathometer

The line-float fathometer is the simplest method suggested to date as a solution to the problem. It is inexpensive, requires no special training on the part of the personnel, and appears to have considerable merit.

The indicator consists of ten wooden veneer squares, $8 \times 8 \times 1/8$ inches in size, painted yellow and fastened by staples to $1/2$-inch cotton tape (see fig. 16). The tape passes diagonally across the squares, and the distance betweeen the center of adjacent squares is 2 feet with the tape extended (fig. 17). A steel plate, also $8 \times 8 \times 1/8$ inches in size, at one end of the string is the anchor.

In operation, the packaged units are mounted in a suitable launching mechanism in the bomb-bay of an airplane, and dropped at predetermined spacing by means of an intervalometer as the plane flies across an approach beach. The top veneer square is fastened to the adjacent square by means of four tapes so as to give a "parachute" effect and insure that the anchor falls faster than the rest of the squares, thus stringing them out so that they are completely extended when they enter the water. The anchor enters the water and sinks to the bottom. The number of floats remaining on the surface subtracted from the total number of floats indicates the depth of the water. The squares remaining on the surface are photographed by a plane equipped with a suitable camera.

The basic idea was tested by dropping a series of indicators by hand from the gondola of a blimp. Drops were made in the calm waters of San Diego Bay and in the ocean adjacent to the surf line (see figures 18 and 21). Some difficulty was experienced in dropping the indicators by hand in the ocean so as to cause them to land in water within their range; less trouble was encountered in the Bay (see figures 19, 20, and 23, the last of which was taken from a blimp).

The indicators dropped in the ocean were subjected to wave action which caused the tapes to rise on a slant rather than vertically as shown in figures 21 and 22 (the latter taken from the blimp). Tables I and II give the data on the drops in the bay and ocean, respectively.

Several modifications suggest themselves which might operate to increase the accuracy of the indications. The anchor shape might be changed to that of a sphere and/or increased in weight to prevent wave action from causing the anchor to shift in a vertical plane. The veneer squares might be made so as to provide greater buoyancy and thus tend to overcome the slanting rise of the string in agitated water.

Full scale operations with high speed aircraft have not been attempted, nor has full development of the device been planned. The exploratory test is presented as a suggestion which merits full development and tactical evaluation.

table I

UNITS DROPPED IN THE BAY

Unit No.	Squares on Surface	Indicated Depth (ft.)	Sounding (ft.)
16	7	6	7
17	7	6	8
18	6½	7	8
19	6	8	9½
20	6	8	10

table II

UNITS DROPPED IN THE OCEAN

Unit No.	Squares on Surface	Indicated Depth (ft.)	Sounding (ft.)
13	2	16	15
3	2	16	16
4	2	16	12
14	3	14	12
5	3	14	13
8	2	16	13

Figure 16. An indicator unit, packed condition.

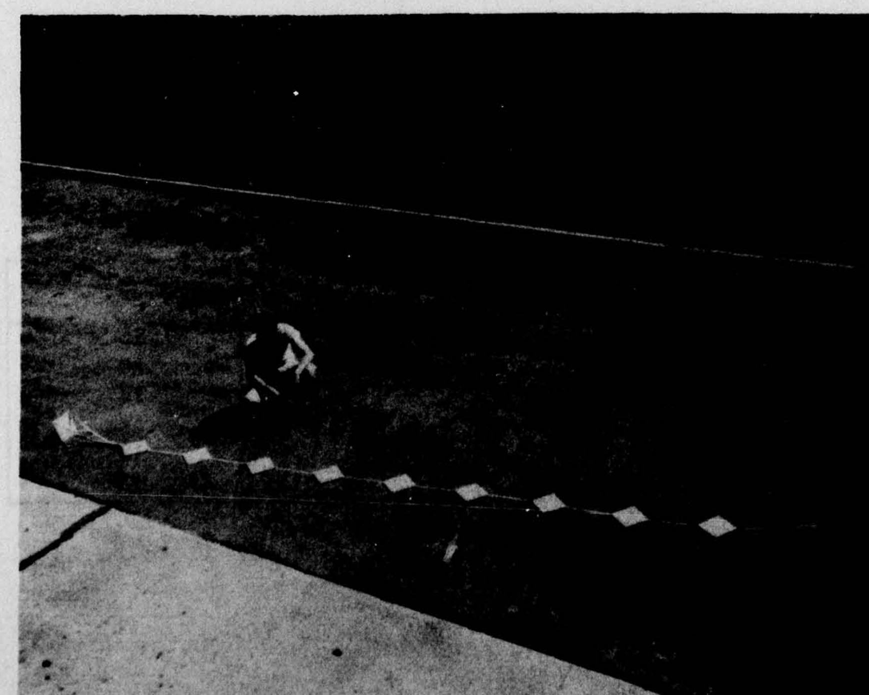


Figure 17. An indicator unit, extended condition.

Figure 18. Units being dropped from blimp

Figure 19. Units dropped in San Diego Bay

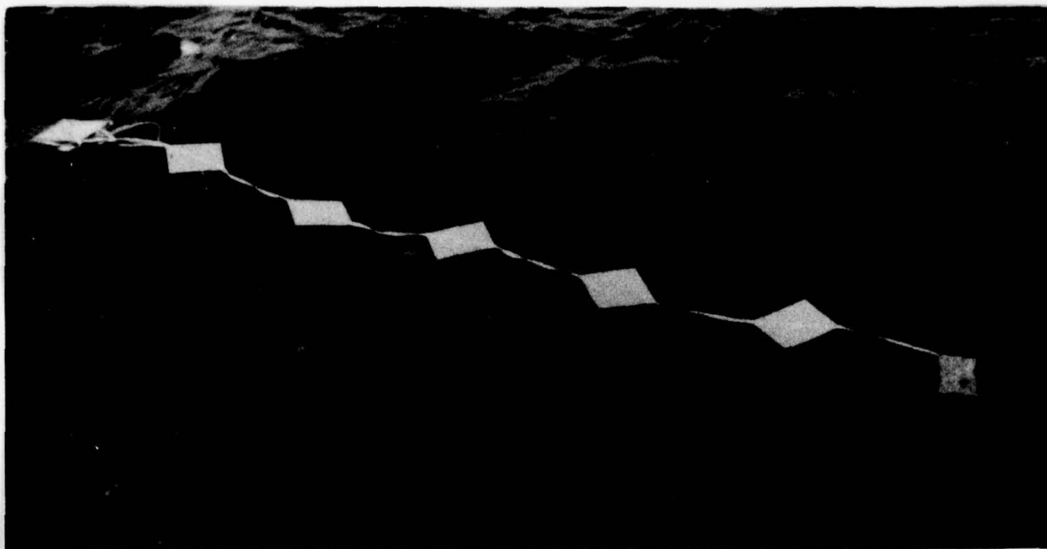


Figure 20. Units dropped in San Diego Bay.

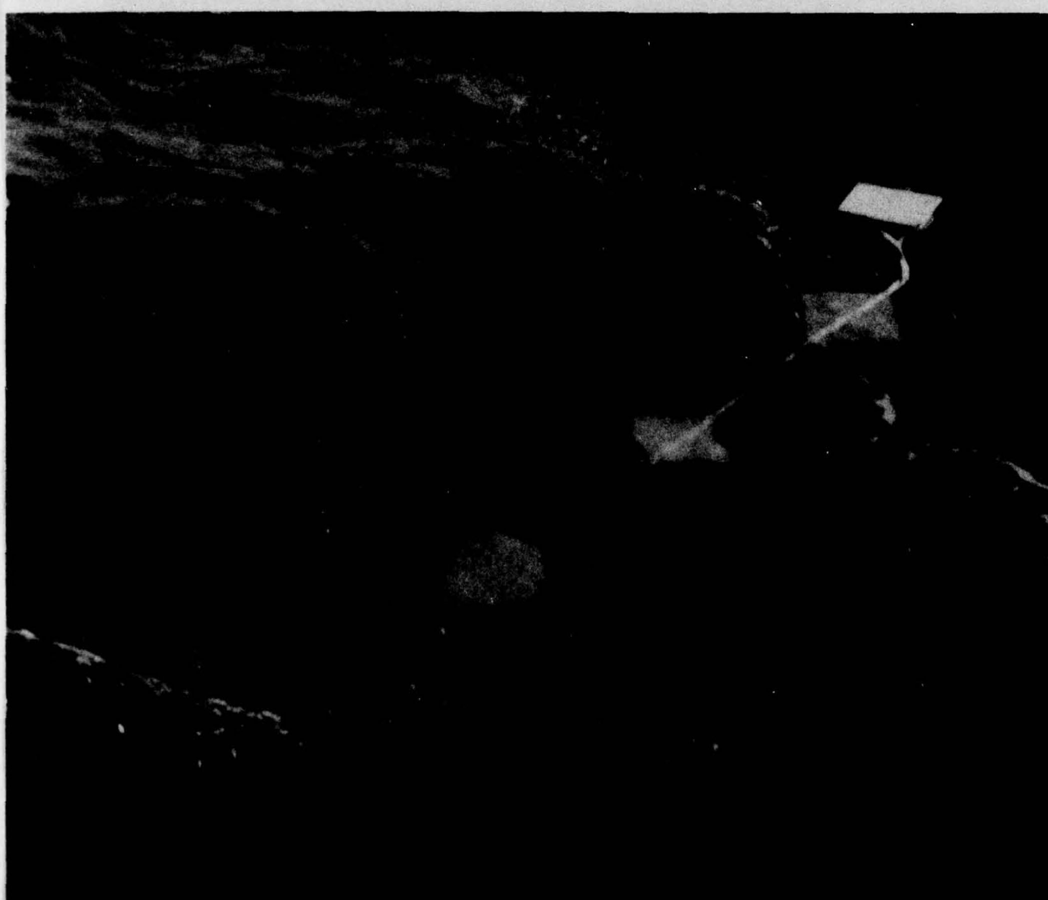


Figure 21. Units dropped in ocean; slant effect visible.

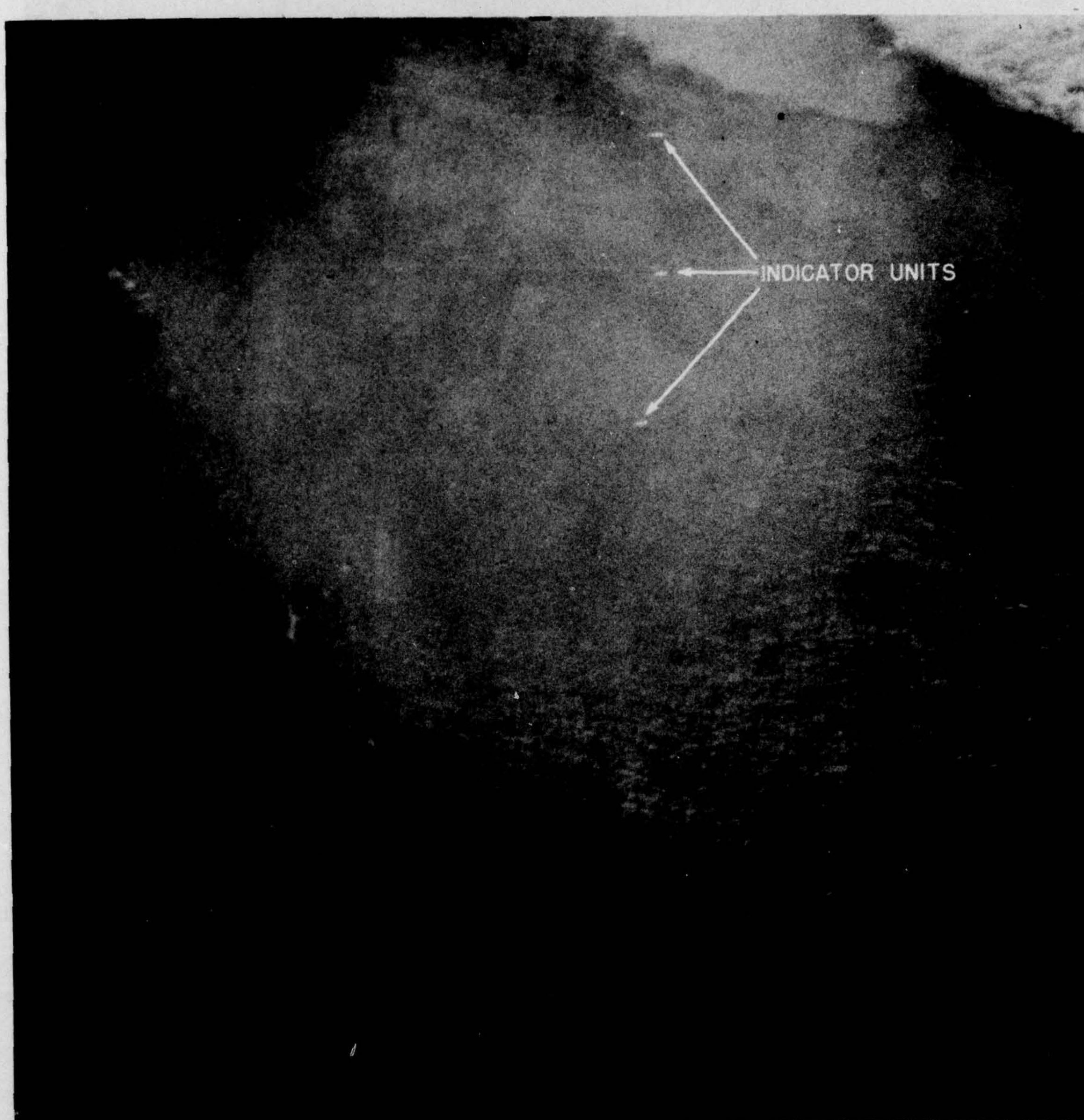


Figure 22. Aerial view taken from blimp of units dropped in ocean

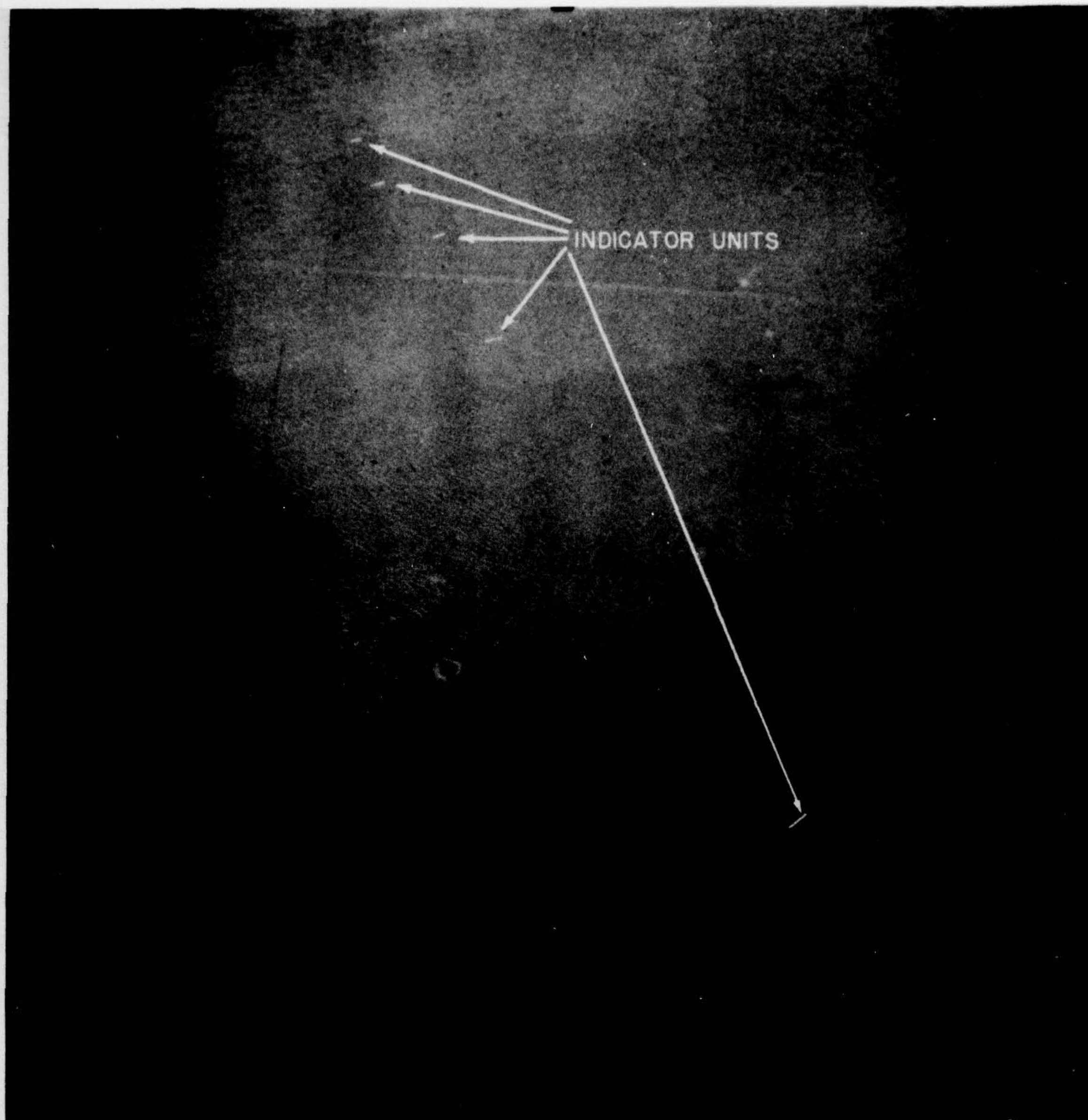


Figure 23. Aerial view of indicator units dropped in San Diego Bay

references

1. "Underwater Depth Determination," Photographic Interpretation Center Report 46, OPNAV-16-VP-46, October 194[illegible].

2. "*CXKD and Lead-Line Expendable Sounding* Equipment" Completion Report, UCDWR No. U-346, File No. 02.135, Problem No. 7C, 1 June 1946.

3. "The UDT Paddleboard Sounding Equipment (A Modification of the CXKD Expendable Echo Sounding Equipment)" Completion Report, UCDWR No. M-449, File No. 02.135, 30 September 1946.